FACTORS AFFECTING TOMATO YIELDS - REPORT OF 1960 COOPERATIVE PROGRAM

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The acreage of tomatoes grown for processing in Ohio is concentrated in the northwest quarter of the state. In recent years, as the average yields for the state have increased, the impressive increases have occurred in the northern portion of this region. With exceptions, yields in the southern section have lagged behind.

In 1960, the Horticultural Department of the Ohio Agricultural Experiment Station undertook an investigation of this situation. With the volunteered cooperation of several growers, fieldmen and canners, experimental plots were located in eight commercial tomato fields scattered from Greenville on the south to Bryan and Genoa in the north. Seven of these fields produced data which may be considered valid for the purposes of the study.

Table II indicates the varieties which were planted. These varieties, with the exception of Fireball, were chosen for their resistance or susceptibility to temperature extremes. Urbana and Hotset have an inbred ability to set fruit in periods when the temperature is high enough to prevent fruit set in most commercial varieties. Temperature records were kept at five of the locations; rainfall records were kept at six locations. Other types of observations were made to adequately chronicle the condition of the plants as the season progressed. Observations which proved to be particularly relevant are indicated in the tables or are described in the following discussion.

Main Observations Made in 1960

Notice (Table I, lines 1 and 3) that the fields south of U.S. Route # 30, with one exception, had the lowest yields. Table I, lines 4, 5, and 6, presents the rainfall during the critical part of the growing season and the average maximum and minimum temperatures for the hottest period of the summer. Temperature differences between various locations during this period are typical of the season as a whole. Neither temperature nor rainfall variations provide an adequate explanation of the yield differences.

The number of fruit (one inch or greater in diameter) which were on the plants just before harvest is shown in line 7, Table I. The size of harvested fruit is shown in line 8, Table I and in Table IV as weight per fruit. Obviously, neither of these quantities was a contributing factor to the major yield differences.

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TABLE I

Summary of General Information

		Location						
		A	B	C	D	E	F	G
1.	Direction from Rt. 30	north	north	near	south	south	south	south
2.	Planting date (1960)	5/31	5/23	5/21	6/1	5/23	5/21	5/21
3.	Av. yields (all vars.)	18.9	16.2	18.5	10.2	11.2	8.7	17.7
4.	July and August rain. (")	5.30	6.35	3.66	-	5.55	6.29	6.30
5.	Av. day max. temp. in hottest period (^{o}F)	93	87	93	-	96	94	-
6.	Av. night min. temp. in same period	66	65	69	-	68	64	-
7.	No. fruit per plant just before first harvest	37	35	44	44	39	57	46
8.	Av. wgt. per fruit (lbs)	.25	.28	.24	.29	.24	.30	.23
9.	Period of vine decline	v.late	late	v.late	early	v.early	v.early	late
10.	Fruit spoiled on vine	few	few	few	many	intermed.	many	few
11.	Relative depth of rooting	deep	deep	deep	shallow	shallow	shallow	deep

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TABLE II

Yield to August 29 ± 1 week

Variety	Location A	B	C	D	E	F	G
	tons per acre						
Fireball	7.0	11.8	10.5	10.0	10.0	13.5	19.1
Urbana	5.3	7.8	4.9	10.0	6.8	6.2	12.2
Rutgers	4.1	7.0	6.6	9.0	4.5	6.6	8.4
Glamour	4.1	6.5	9.8	9.6	4.5	8.3	11.8
Hotset	3.0			12.6			

TABLE III

Total Yield

Variety	Location A	B	C	D	E	F	G
	tons per acre						
Fireball	11.6	13.5	11.0	10.0	10.0	13.5	19.1
Urbana	20.8	18.6	23.1	10.0	13.8	6.2	20.4
Rutgers	19.5	17.3	19.3	9.0	11.2	6.6	14.3
Glamour	18.8	15.5	20.6	9.6	9.7	8.3	17.1
Hotset	23.6			12.6			

TABLE IV

Average Weight per Fruit

Variety	Location A	B	C	D	E	F	G
	pounds						
Fireball	.26	.27	.19	.24	.22	.27	.21
Urbana	.25	.23	.21	.28	.20	.24	.21
Rutgers	.27	.29	.25	.31	.25	.33	.24
Glamour	.29	.31	.31	.36	.28	.37	.25
Hotset	.19			.25			

TABLE V

Summary of the Quality Score
Sheets of Canned Whole Tomatoes
From Three Locations*

	pH	Total Acidity	Drained Wts.Score	Wholeness	Color	Absence of Defects	Total Score	Grade
Fireball	4.05	6.49	17.64	18.48	26.73	28.41	91.09	B
Urbana	3.99	7.44	16.59	17.74	26.98	29.68	91.15	B
Rutgers	4.07	6.85	17.26	17.37	26.53	28.94	89.16	B
Glamour	4.03	6.71	19.05	17.56	27.36	29.81	93.74	A
Hotset	3.97	7.41	18.54	18.43	27.88	29.64	94.51	A

* Scored and compiled by W. A. Gould

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Note that the observations of lines 9, 10, and 11 show a close correlation with the yield variations. Fields D, E, and F, which had low yields, had a higher than normal amount of fruit left unpicked. The plants in these fields declined early in the harvest period. Careful removal of soil from the roots disclosed that the roots in these fields were largely restricted to the upper 8 to 10 inches of the soil. Location of the fields on a soils map shows that Fields A, B, and C have soils formed on the site of the ancient bed of Lake Erie. These soils are high in organic matter and are relatively deep. The soils of fields D, E, and F were formed on sites where the drainage was not impeded. They are low in organic matter and relatively shallow. The soil of field G was formed in a drainage basin and is very much like the soils of the Old Lake Bed.

The experimental plots were in good condition at all locations as of August 1. The condition of the plants in fields D, E, and F deteriorated rapidly after that time. The plants appeared to be suffering from lack of water. In the last part of August the fruit began to ripen faster than it could be picked on a commercial scale. This situation was aggravated by the fact that the fruit did not color properly. Fruit which was left unpicked on the basis of color was apt to be over-ripe at the next picking. In some cases the vines became so congested with spoiling fruit that it would be uneconomical to pick the good fruit.

The plants of fields A, B, C, and G remained green. The fruit ripened evenly and developed normal color. A high proportion of the fruit was picked. Examination of the soil showed that the plant roots penetrated to considerably greater depths than they did in fields D, E, and F.

Observation of fields D, E, and F revealed another point of interest. Fields E and F had a naturally occurring clay pan. Field D, however, had a deeper soil, but a plow sole about 3 inches thick was present at a depth of approximately 9 inches. This, evidently, had much the same effect as the natural clay pan.

Soils which crack upon drying allow roots to penetrate past layers which have been compacted by tillage operations. Soils which do not crack under the same circumstances lack this advantage. Fall plowing may have particular advantage on this latter type of soil.

Conclusions from the Main Observations

The effective depth of the soil appeared to be a factor which greatly influenced tomato yields in Ohio in 1960. In fields where roots could penetrate to the deeper supplies of soil moisture, the plants survived the dry period of August and September in excellent condition.

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Temperature records did not indicate that a temperature differential exists within the region which is of sufficient proportions to greatly influence yields. U.S. Weather Bureau records of temperatures in other years tend to confirm this opinion. This is not to say that temperature is not a limiting factor in the region as a whole. The better performance of the Urbana and Hotset varieties (Tables II and III) may be an indication that it is. These opinions cannot be accepted as established facts, however, until they have been tested in a season of higher temperatures than occurred during 1960.

The Problem of Shallow Soils

In a year with a perfect distribution of rainfall, a shallow soil, well fertilized, will probably yield as well as a deep soil. The season of 1960 exemplifies the year when a dry period comes during the last phase of plant development. In other years, a hot dry period may occur when the main crop of fruit should be setting. Under such circumstances, the failure to set fruit will probably be more pronounced on shallow soils than on deep soils.

In general, the tomato growing operation on shallow soils must be at a competitive disadvantage, unless it has advantages which were not detected in the observations made in 1960. The disadvantage may be diminished by certain practices. To conserve moisture, the density of the foliage should not be as great as that on a deeper soil. Less plants per acre, smaller vine types, or lower nitrogen applications should be the rule, as compared with recommendations on deeper soils. The neglect of weed control would be disastrous in some cases, since soil moisture is the critical factor. The same irrigation program which would not increase yields on deep soils might prove very beneficial on shallow soils. However, the cost of shallow soil plus irrigation should be compared with the cost of deep soil to weigh the comparative advantages of each.

Should mechanical harvesting remove some of the emphasis on high yields and place more emphasis on economy of land and cultural practices, shallow soils may maintain their place in the tomato picture of the future. When moisture becomes a limiting factor, the fruit matures more rapidly. Taking this aspect into account, shallow soils may find a place in the scheduling of the mechanical harvest.

Miscellaneous Observations in 1960

Average temperatures during June and July were cooler than normal. In this cool period, Verticillium Wilt attacked a majority of tomato fields. Most fields recovered as temperatures began to

get back to normal. There were two types of adverse effects. First, blossoms did not set well during this period. Second, the crown leaves withered, exposing a number of fruit. This fruit had a tendency not to gain full color.

At one of the experimental plots, the young plants were subjected to a heavy rain storm in the third week of June. These plants had between 10 and 35 flower clusters, depending on the variety. These were thoroughly spattered with mud. A period of warm, humid weather followed. Three weeks later, these plants were suffering from a severe attack of a bacterial nature. The stems and fruits were spotted, and many of the flower buds turned yellow and shrivelled.

In the cases of both types of disease referred to above, varieties such as Rutgers and Urbana recovered, because of their continual growth pattern. The Fireball variety did not recover. Having the determinate type of growth, such varieties set fruit in a comparatively brief period, then cease in vegetative growth. Their yield is greatly influenced by conditions during this brief period, since they have only a minor capability of producing additional blossoms. This should be kept in mind when considering this type of plant for mechanical harvesting.

Acknowledgements

The need for this investigation was brought to the attention of the Department of Horticulture by Mr. William Gast of St. Henry during a meeting of the Research Committee of the Ohio Canners and Food Processors Association. The project was fostered and activated through the efforts of Dr. W. A. Gould, Head of the Processing Division of the Department of Horticulture, Dr. W. N. Brown, Head of the Vegetable Crops Division, Dr. F. S. Howlett, Chairman of the Department of Horticulture, and Mr. E. C. Wittmeyer, Extension Specialist in the Department.

Independent growers who participated were: Mr. Rex Springer and Mr. Meredith Springer and family, of Van Wert; Mr. Harmon Haye of Stryker; Mr. James Parlette and Mr. Clarence Parlette and family, of Genoa; Mr. Henry Stucke and family, including Mr. Thomas Stucke, of Maria Stein.

Canners and their representatives who participated were: Mr. Von Jones and Mr. John Jones (The Greenville Canning Co.); Mr. Charles Stemley and Mr. Neil Stemley (The Stemley Canning Co.); Mr. William Gast (The Beckman and Gast Co.); Mr. T. A. Vanderhorst and family, including Mr. T. A. Vanderhorst, Jr. (The Vanderhorst Cannery); Mr. Ralph Klosterman (Stokely-Van Camp, Inc.); Mr. S. S. Snyder and Mr. Paul Korn (St. Marys Foods, Inc.); Mr. Richard Boucher (The Bryan Canning Co.).

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Plants of the Rutgers, Glamour, Fireball, and Urbana varieties were supplied without charge by Mr. Ed Edmondson, Service Plant Company, Omega, Georgia.

Due to the efforts of these individuals and these organizations, the investigation has successfully produced very helpful data. The essentiality of the "and families" mentioned above is not to be underestimated.

Horticultural Mimeograph Series No. 249

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